Natural Packages

In this investigation, students construct an understanding of the concept of a ratio in the context of packaging. They begin with nature's own packaging and move on to consider human adaptations of this process. They peel a banana and compare the mass of the edible part to that of the peel. The same process is used with an orange, a peanut, an egg or with any other items they choose to investigate (e.g., a bunch of grapes). Next, they bring in examples of human-made packaging, make the same measurements, and compute the same ratio. How does human packaging compare with nature's? Along the way, there are opportunities to tie this information into an understanding of the function of the packaging and the environmental context in which the various "packages" grow.

Students develop their understanding of many important processes both mathematical (using ratios, finding percentages, graphing, and averaging) and scientific (measuring, recording data, interpreting data and generalizing). The basis for this investigation is an AIMS Project (AIMS Education Foundation, PO Box 8120 Fresno, CA, 93747).

Begin by asking the students how many of them brought their lunch to school today. Does anyone have a banana? an orange? an apple? You can produce one or accept a volunteer banana. Ask students what they do with banana peels. How much of the fruit are we throwing away? How much is edible? How will your students express this ratio? as a fraction (e.g., "I think that about 9/10 of it is edible.")?, as a percent (e.g., "I think the peel is probably around 20% of the whole thing.")?, as a ratio (e.g., " The ratio of peel to fruit is probably about 6 to 1.")? In any case, it is important for them to make a prediction so that they will have a stake in the investigation. Ask them to speculate also about the same ratio for other fruits. Which are the most efficient? What do we mean by this term? Generally they will decide that the lower the percentage of "wasted" fruit, the more efficiently it is packaged. Record their predictions. The discussion is an important step in the process of building the cognitive schema necessary for your students to make useful sense of the rest of the investigation.

Ask the students, either as a whole class or in small groups, to devise a plan to determine the percentage (or ratio, or fraction, etc.) that is wasted for the banana. What do we need to know? How will that information help solve the problem? How can we get that information? How many bananas do we need to test? At this point, you can ask them to devise a chart for recording data or you can suggest (or simply distribute) a chart such as the following:

	Total mass in grams	Mass of the peel	Mass of the edible part	Ratio: edible to total	Percent that is edible
banana 1					
banana 2					
banana 3					
banana 4					
banana 5					
SUM					
AVERAGE					

Once they have found the percentage that is edible, how can they represent these data to someone else? Should you use bar charts?, pie charts? Should you aggregate the data into a single average percentage or display all of the individual percentages ? It is very effective to have another class working on the same investigation simultaneously. Your students can then trade information and results, thereby increasing their sample size. This class can be next door, in another building, or, if you have e-mail connections, on another continent! This connection increases motivation to get good results and to express these data in ways that will be useful for others.

Once the procedure has been established for bananas, recall students' predictions for other "packages". What will this percentage (or ratio, or fraction) look like for oranges, peanuts, grapes, etc.? Get students to talk about these predictions. You might even want to set up a prediction sheet and see which group or individual gets closest to the "correct" percentage which will be determined through experimentation. Assign groups of students to conduct these investigations following the procedures established with the banana.

This might be a good time to pause and consider the implications of the differences you are finding. Why, for example, does the banana have a larger percentage of its mass devoted to packaging than does a hard-boiled egg? What is the function of the banana peel? What is the function of the egg shell? How are the environments in which a banana and an egg develop the same? How are they different? How does the function of the peanut shell differ from that of the grape skin? It is important for students to consider these questions. By spending some time formulating, investigating, and communicating their answers to these kinds of questions, students are building an understanding of the nature of science. They are, in fact, "doing" science. Can you afford to do this in your mathematics classroom? Can you afford not to? Is there a science teacher in your building who might want to cooperate with you?

Next, students can move into an investigation of human-made packaging. When you buy a candy bar from a machine, how much of the whole item (package and candy) do you throw away? What about a can of soda?, a jar of peanut butter?, a package of meat?, a carton of milk? etc. In general, how do the percentages or ratios compare for human packaging as opposed to natural packaging? Is there a difference between the "wasted" part of a natural product and that of a human made product? Again, what is the function of the packages people manufacture and how do they differ from the function of packaging in nature? Which kinds of packages are more likely to be recycled? Why? These questions allow students to construct connections between science and the world they live in, and to build a conception of science as a way of making sense of that world.

Extensions:

Buy a bunch of bananas and repeat this investigation once with a single banana from the bunch every few days in order to observe the way in which the ratio changes as the bananas begins to deteriorate. What is happening to the peel? To the banana? What part does this deterioration play in the life cycle of the banana?

Take a look at the average ratios you are determining. List them in order from the highest percentage to the lowest. Can you find some similarities (environmental, functional, etc.) between the items at the top of the list, in the middle, at the bottom?

How would you apply this sort of analysis to a book? a movie? a human being??